RP48

PROGRESS REPORT OF ROADWAY REVEGETATION STUDIES FOR THE MULLAN LINE WEST SECTION OF INTERSTATE I-90 1973-74

by
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This report is a cooperative study between the Intermountain Forest and Range Experiment Station, U.S. Forest Service, and the Idaho State Department of Highways. The report outlines the principal findings and accomplishments of revegetation studies conducted on the Mullan Line West portion of Interstate I-90 for the 1973-74 period. The research project was initiated in 1970 as a five-year study but operable through yearly renewals. The results are reported for four major study objectives: (1) Species selection, (2) Seedbed preparation and planting procedures, (3) Environmental and climatic influences, and (4) Plant composition changes.

Studies were instigated to evaluate the practice of seriating or benching cut slopes and seeding shrub and tree seeds with herbaceous plants onto road disturbances. The Mullan project transverses a most scenic mountainous route in northern Idaho, which has been severely altered to facilitate a modern highway. The barred cut and fill surfaces are difficult to revegetate, but require an effective and appealing plant cover to stabilize erosion and maintain aesthetic resources. Attempts have been made to replant, through direct seeding and transplanting, a representative assortment of native shrubs and trees which are best adapted to the exposed and mixed substrata. The Mullan project occurs in an area of high rainfall which assists plant growth but presents problems of surface erosion and mass slumping.

Although conditions aligning the road project present problems that are somewhat endemic to this site, the barred slopes are similar to disturbances created by roads constructed in other portions of the state. Consequently, improvements achieved at the Mullan site in seedbed preparation and planting techniques would be of significant importance to other roaded areas. Planting practices which would facilitate the use of shrubs and trees would greatly improve the possibility of planting sites which now are left untreated. The cover and plant composition of sites seeded to only a herbaceous understory would also be enhanced with woody plants.

Due to the enormity of the project, three years were required to construct the road. As sections of the route were built the completed portions were fall planted. Study plots were established on representative areas that were seeded each year; the final plots were established in 1973. A minimum of five years appears necessary to evaluate most studies, and the 1973-74 period completes the third year of this project.

Information derived from the study has already greatly assisted the reclamation of other disturbances, particularly sites with similar physical conditions. Benching of cut slopes has provided an improved seedbed that has stimulated considerable interest from other land managers. Consequently, this project has attracted special attention and is providing an excellent area for continuing studies. During the 1973-74 period the author utilized information from the study in preparation of a paper titled "Selecting Plants to Rehabilitate Disturbed Areas" which was presented at a symposium jointly sponsered by the Society for

Range Management, American Society of Agronomy, and Crop Science Society of America, Appendix I. Personnel from the Idaho State Department of Highways also presented a summary of the project at the annual WASHO meetings held in Portland, Oregon.

OBJECTIVE 1

SPECIES SELECTION

Most species utilized in the roadway and barrow pit plantings appear well adapted to these disturbances. Seeded grasses and forbs have attained a dominant vegetal cover within the first growing season following planting (Table 1). Grasses have developed a remarkable cover on nearly all sites. The rapid growth rates and low mortality of young seedlings have contributed to the excellent stands. Although grass density is more uniform on fill slopes than for benched cuts, plants are well established on all sites. The average ground cover for seeded grasses recorded on a typical fill slope is presented in table 1. Note that within one growing season grasses occupied over 50% of the surface area. After two years, the ground cover increased to a figure of 65%.

Orchardgrass and timothy are the most aggressive species included in the plantings. Both grasses provide an effective ground cover, particularly on fill slopes which are subject to surface erosion (Fig. 1). The steep fill slopes are highly erosive if left bare. Normally both the cut and fill surfaces are left in a rough condition by road construction. The rough surface provides an excellent seedbed for broadcast planting. However, if the bared areas are not seeded the year they are constructed,

Table 1. Average ground cover on road fill slopes for seeded grasses

Species	Date: 5/24/71	6/8/71	6/15/71	8/24/71	8/24/72
	Percent Ground Cover				
Canada bluegrass				5.63	9.17
Intermediate wheatgrass				4.83	1.20
Orchardgrass				19.07	19.73
Tall oatgrass				1.30	
Timothy				20.40	19.30
Grass seedlings	1.27	11.37	15.70		
	1.27	11.37	15.70	51.23	65.10

Figure 1.--Orchardgrass and timothy develop an excellent cover on fertilized sites.

soil erosion negates the seedbed qualities. Observe in Figures 2A and B the first year erosion of soil fines which occur from a fill slope that was not planted. As sites are eroded the surfaces become very hard and plants are not easily established.

Although forbs were not heavily seeded with the grasses and shrubs, their presence has been highly beneficial. White clover was planted in all seedings, and has slowly increased in ground cover. The legume is well adapted to the infertile soils, and does not decline in vigor and herbage production as the applied fertilizers are exhausted. Most grasses show a definite decline two or three years after fertilization. Range type alfalfa was seeded in the 1972 seedings, and has responded equally as well as the clover. Most alfalfa plants are more productive than the clover, and substantially increase the vigor of the surrounding grasses.

A primary concern of the project has been to establish, through direct seeding, a mixture of native shrubs and trees on all cut and fill slopes. Because separate plantings were not possible, the woody plants were seeded with the grasses and forbs. This approach encouraged competition between the more aggressive grass seedlings and the slower developing trees and shrubs.

Nearly all seeded trees and shrubs emerged from broadcast planting. The response has been satisfactory for all plantings conducted in the fall and winter months. However, grass competition has suppressed and eliminated many woody seedlings. Losses are more pronounced the second year after planting. As grass attains a ground cover approaching 40 to

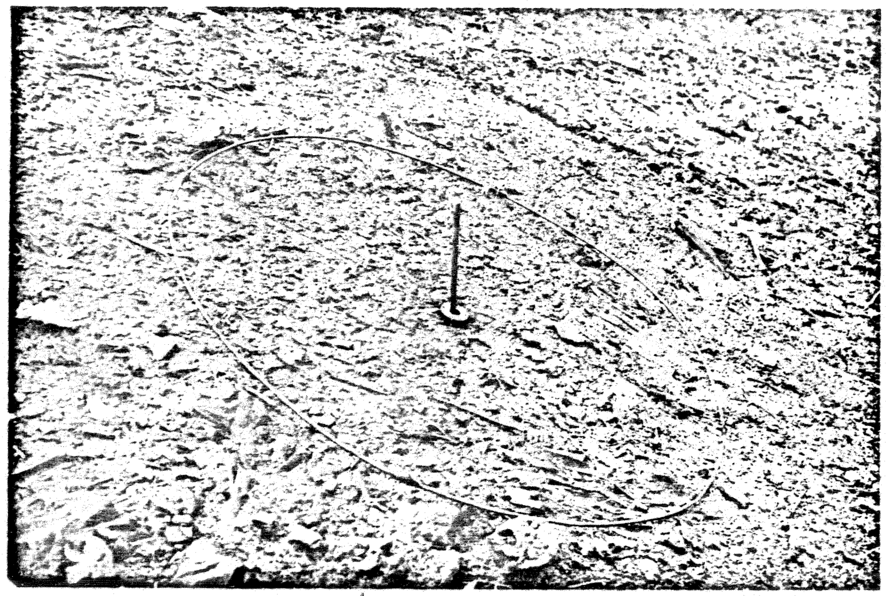

Figure 2.--Fill slopes are highly erodible if left unplanted:

A. Soil fines dominate the mixed fill materials;

B. Within a few months small soil particles are removed by surface erosion.

50 percent, trees and shrubs succumb. Woody plants which become well established are less sensitive, and usually are not lost.

Trees and shrubs are well adapted to the infertile subsoils which have been exposed. Contrary to the grasses, the young shrubs and trees do not require heavy applications of fertilizer to assist in seedling establishment. Consequently, trees and shrubs which often are encountered alone have developed excellent plants. A summary of the more successful species was reported in the 1973 annual report. Few changes have been observed in the rankings already presented. However, sufficient seed of rockspirea and mountain ash were purchased and added to the 1972 fall seedings. Both shrubs have grown remarkably well on the disturbed slopes. The seedlings develop rapidly and appear to be very competitive with the seeded grass (Figure 3). The first year growth rate of both shrubs exceeds that recorded of most other shrubs. The growth habit, form, and flowering characteristics of these plants cause them to be very attractive and useful in roadway plantings.

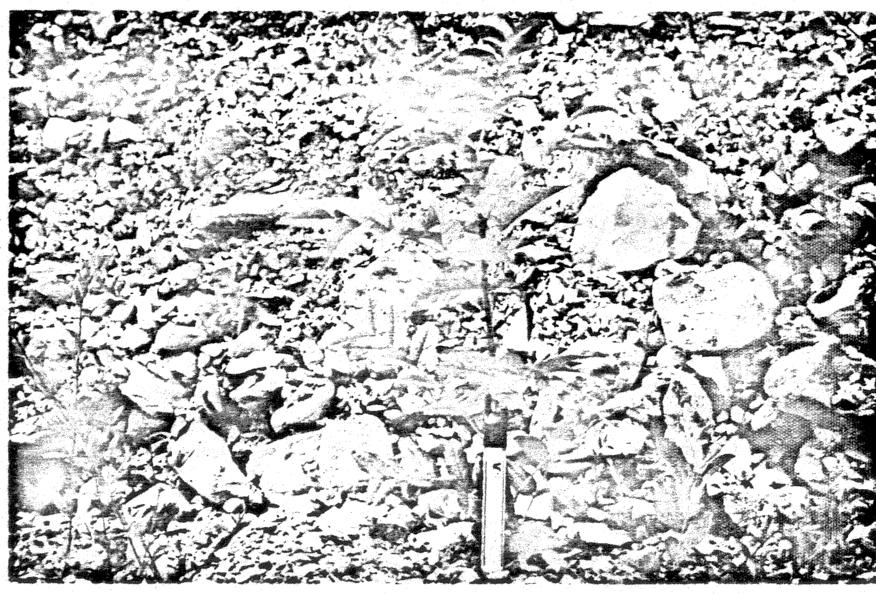

Figure 3.--Two-year-old seedlings of mountain ash grow exceptionally well on infertile subsoils.

A number of tree and shrub seedlings and transplants have died on certain sites, but losses are primarily attributable to poor planting procedures. Most tree and shrub species have established and grown satisfactorily, if properly planted. Planting systems must be developed which would favor the growth of the slower developing woody plants, and yet insure an adequate ground cover of herbaceous species. Considerable progress has been developed in this regard, and is reported in Objective 4 of this report.

Site conditions, aligning roadway disturbances, can be used to promote the growth of certain species, such as trees and shrubs. The infertile substrate which is exposed in a roadcut, and utilized to construct a roadfill, can be fertilized to promote or limit the growth rate of seeded species. Most grasses are highly dependent upon the availability of soil nutrients, and vegetative growth can be regulated through fertilizer applications. Limiting the fertilizer or delaying the dates of application would benefit the trees and shrubs without eliminating the seeded grasses. In addition, reducing the grass seed to about 4 pounds per acre has substantially improved the survival of seeded trees and shrubs. Canada bluegrass has responded very well as a companion crop for seeding with trees and shrubs. This grass is slower to develop than the orchardgrass, timothy, and smooth brome, but develops a satisfactory cover within two or three years. Consequently, the slow growth rate allows trees and shrubs to establish and grow without severe competitive restrictions. The bluegrass is also less sensitive to low levels of fertilizer than most other grasses. This species has consistantly increased in total ground cover on unfertilized sites as other grasses have slowly weakened.

OBJECTIVE 2

SITE PREPARATION AND PLANTING

An adequate number of grass, forb, tree and shrub seedlings have been recorded on both the mini-bench surfaces and fill slopes for all three years of planting. Benching the cut slopes provides an excellent seedbed for broadcast planting. Individual benches constructed at the Mullan site are of proper size and length to intercept surface runoff from rainstorms or snowmelt. The cut faces do not generate high velocity flows as runoff, and soil sloughing has not become a problem. Benching the rocky cuts has created planting sites which otherwise would have been left untreated. This method of road construction should be recommended for sites that consist of hard but highly fractured bedrock. Benching has also been successful as a temporary measure in stabilizing highly weathered parent materials. The short term control allows sufficient time for seeded species to become established, which prevents further soil sloughing. If properly seeded, plants are well distributed on the mini bench surfaces. As expected, the level bench intercepts and retains a high percent of the broadcast seeds. Moisture is also collected by the bench, which simulates a greater amount of vegetative growth than is recorded on the cut faces of the mini bench.

However, as recorded in Table 2, the mini bench surfaces provide a favorable microenvironment for seeded plants.

Table 2. Grass density encountered throughout different positions in a mini-bench surface

Plot Number	POSITION OF MINI-BENCH			
	Level Bench Sedgment	Low 1/3 Segment of Cut Face	Mid 1/3 Segment of Cut Face	Upper 1/3 Segment of Cut Face
	Number of Live Plants			
1	71	65	65	60
2	45	25	31	26
3	75	25	15	15
4	46	27	2	2
Average	58	35	28	25

Plants are often widely scattered on the mini benches which is due, in part, to irregular seeding. The sites are often inaccessible to the hydroseeder, and many areas are missed in planting. Seeds are frequently blown upslope, and the heavy seeds are carried for a greater distance than the light weight species. Consequently, irregular seeding patterns are often encountered.

The rocky surfaces of most mini benches favors the establishment and survival of seeded trees and shrubs. Young seedlings are widely scattered throughout the rubble (Fig. 4). To survive, plants must be located in areas where soil fines occur. The high percentage of rock in the surface profile creates irregular pockets where soil fines have accumulated. Consequently, plants are widely scattered, and grass competition is not a serious problem. Although small seedlings often succumb to drought on these shallow soils, the Lookout Pass area usually receives sufficient summer storms at regular intervals to recharge the rapidly drying soils.

Transplanting nursery stock of shrubs and trees onto highly erosive sites has proven to be successful in reducing soil erosion. The survival of transplants on rocky mini bench sites has been very successful, if planted with adapted species. Unfortunately, suitable planting stock has not been available or used in some sections of the road. Plant survival has also been seriously reduced by poor planting. Ratings taken in early June 1973 showed the immediate effect of improper planting on the survival of ponderosa pine (Table 3). Nearly 55 percent of all transplants failed to establish and died soon after planting. All

Figure 4.--Tree and shrub seedlings can be successfully established by broadcast planting on the rocky surfaces of the mini benches.

Table 3. Transplant survival for 1973 plantings at the Big Creek barrow site

Species	Percent Survival	
	June 1973	Aug. 1973
Ponderosa pine	44	24
Black locust	79	78
Siberian peashrub	78	62

dead plants were excavated and examined to determine the possible causes of death. Nearly all plants were poorly planted, the roots were not properly covered with soil and roots were most often doubled up in a shallow hole.

Losses of pine transplants continue throughout the first growing season, as the weaker plants succumb during the summer period. However, few plants which survive the first year die during the second or third year after planting. If care is given in planting, considerable improvement in survival and plant vigor could be achieved.

The growth rate of most conifers has been slow the first two years after planting. However, once established the plants produce good terminal growth rates (Figure 5). Ponderosa pine has also been more sensitive to soil moisture than most deciduous shrubs. Approximately 50 percent of all pine transplants survived from the 1972 plantings, as compared to about 24 percent survival for the 1973 plantings. The annual precipitation in 1972 was considerably higher than in 1973.

First year survival for black locust and Siberian peashrub planted in 1973 was 78 percent and 62 percent, respectively (Table 3). Nearly 80 percent of all transplants survived the first year. Losses occurred in the early spring months; again, a result from poor planting. Few plants died in the mid-summer period. These two species are well adapted to the harsh sites, and can be successfully transplanted as bare rootstock.

Transplant losses have not been affected by understory competition. The grass density on most benches has not suppressed the transplant

Figure 5.--Ponderosa pine requires one or two years to become established on the harsh bench sites.

survival. If trees and shrubs are transplanted in the spring following fall grass seedings, the woody plants are able to compete with the developing grass cover.

Study plots have demonstrated that Woods rose, mountain snowberry, and skunkbush sumac are plants which would be adapted to these problem sites. Although transplanting is a more costly method of planting than direct seeding, the process can be used to selectively establish a desired array of plants on most disturbances.

<u>Lonicer</u> <u>ciliosa</u>, orange honeysuckle, has been encountered near the Elizabeth Park barrow site, and appears to be a very promising species for planting on disturbed soils. The low statue shrub grows as a trailing vine and forms a dense ground cover. The shrub exhibits a number of promising characteristics: (A) it has survived from exposure to the toxic air pollutants discharged from the Kellogg smelter; (B) the plant roots easily and new rootlets develop from the stem nodes, if the stems contact a moist soil surface; and (C) the shrub is well adapted to the infertile and unstable soil surface and can be useful in planting erosive slopes.

In the fall of 1972, seed that had been broadcast planted with the hydroseeder were collected for germination and viability studies. Sample lots were separated by species and placed in controlled germination chambers. Tests were conducted on the major grass, forbs, tree, and shrub species which were seeded throughout the road project. Comparative tests were also conducted of similar seed lots which had not been run through the hydroseeder.

Visual damage of hydroseeded seeds was detected in three species--snowbrush ceanothus, 9%; western larch, 6%; and lodgepole pine, 3%. Seeds with brittle seedcoat can be broken by the hydroseeder.

The hydroseeder had a detrimental effect on the germination of nearly all species. The impact was recorded by a delay in germination and a reduction in the number of seeds which ultimately germinated (Fig. 6). The reduced germination of hydroseeded seeds may, in part, be due to the germination techniques we used. All seeds were hydroseeded in a water slury, and had to be dried before they could be separated from the Silva-Fiber mulch. Consequently, seeds could have begun to germinate before we were able to dry the mixed material. However, similar conditions occur in field planting, where repeated wetting and drying occurs.

The important test of the effectiveness of the hydroseeder is the establishment of field plantings. Most hydroseedings conducted along the road project have been successful, and seeded plants do not appear to be severely depressed by this method of planting. However, seed losses do occur from the hydroseeder, and sufficient seed should be applied to compensate for the damage.

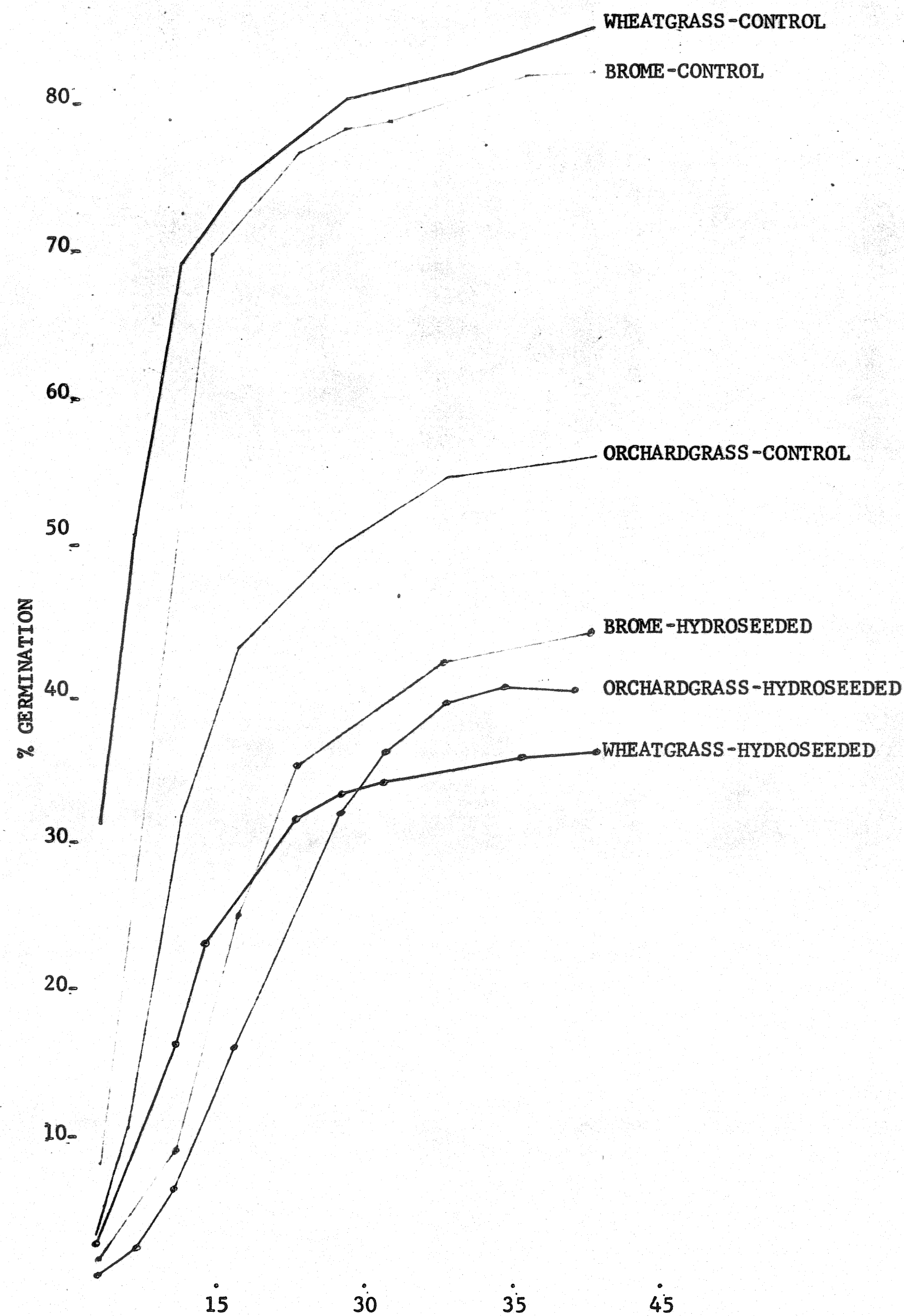

Figure 6. Germination of hydroseeded and control lots of three grasses.

OBJECTIVE 3

ENVIRONMENTAL AND CLIMATIC INFLUENCES ON PLANT ESTABLISHMENT AND GROWTH

Seedings conducted during the fall of 1970, 1971, and 1972 have all resulted in the establishment of a satisfactory ground cover. Total annual precipitation received in 1971, the first summer following planting, was slightly higher than normal; however, in 1972 a reversal occurred. The total annual precipitation recorded in 1972 was much lower than normal, and very little rainfall was received during the growing period. The growth of established plants was not adversely affected during the year of low precipitation. However, fewer seedlings became established. Young plants that did emerge on the rocky benched surfaces succumbed to drought early in the summer. The drying effect was most damaging to shrubs and tree seedlings.

The herbage production of established grasses has not varied greatly during the course of the study. Even during the period of low precipitation in 1972 the herbage produced remained relatively stable. Plants that were green throughout the entire summer of 1971 dried up about mid-August in 1972. This occurred due to a lack of summer precipitation.

Even during periods of low annual rainfall, the planted areas receive an adequate supply of moisture to sustain established grasses. Spring and summer moisture is very critical to the survival of small seedlings. The exposed rocky substrata, which serves as the soil media, has a low water storage capacity and drys rapidly. Consequently, small seedlings cannot survive if plants must rely upon the overwinter storage of soil moisture.

Most seeded species have proven adapted to the road disturbances. Although it is not surprising that the introduced grasses grow very well, the response of less drought tolerant plants is quite encouraging. Seedlings of western larch, grand fir, chokecherry, Holodiscus, and mountain ash have performed well under adverse moisture conditions.

The survival of transplanted nursery stock has been very sensitive to spring and early summer storms. Although plant survival varies among the species that were tested, mortality is directly effected by recurring storms that are received soon after planting. Transplants that become established usually do not produce an abundance of vegetation the first season. Thereafter, yearly growth rates are more responsive to seasonal differences in the amount of moisture received.

Transplanting shrubs and trees as bare rootstock on the benched slopes and barrow sites must be completed early in the spring if plants are to survive. Transplants should be established before the soil surface dries from warming spring temperatures. Early plantings are also more likely to benefit from spring storms than plantings delayed into the late spring period. Approximately 70 percent of all conifers transplanted in the spring of 1973 at the Big Creek barrow site succumbed the year of planting. High mortality is expected of plantings conducted on the rocky sites, but if the sites had been planted earlier in the spring, survival would have been much better.

Climatic differences have not caused an apparent change in the plant composition for sites throughout the project. A difference in elevation of 1,000 feet occurs between the road summit located near the

Idaho-Montana state line and sites near the town of Mullan, Idaho. However, influences in the period of seed germination and seedling emergence have been recorded between different sites. Fill slopes, located near the road summit, remain covered with snow for about ten days longer than slopes studied near Mullan. Seed germination began immediately after the snow receded at the lower sites. The response was not so instantaneously at higher elevation sites where temperatures remain somewhat lower. The delay in seed germination at the upper sites was evident for a considerable period. Plantings, which emerged on the lower sites produced a dense ground cover the first season. The average plant cover for the lower slopes was nearly double the figure recorded for the slower developing plantings on the upper sites. The differences continued to lag through the second year following planting. At the end of the third growing season, the average ground cover and herbage production of most plantings was quite comparable.

It is evident that seedings conducted during the spring period have less chance to fully develop than fall plantings. The surface soil dries quickly and seedlings often fail to produce a satisfactory root system to sustain the plant during the dry summer period.

Spring plantings were conducted on the Big Creek barrow site in 1972. The planting resulted in the poor establishment of shrubs and tree seedlings. The grasses developed somewhat slower than would have been expected from fall plantings. All herbs have since grown well and now provide a good ground cover. The date of planting is critical to seedling survival and plant development and fall plantings are strongly recommended.

Surface erosion is particularly critical on some fill and cut surfaces. An immediate ground cover is essential on these sites to prevent accelerated erosion. Any delay in plant development is potentially damaging. Excessive runoff is often channeled from the road surface onto sections of the fills, which compounds erosion problems. The abnormal discharge often occurs in the spring when the soil surface lacks a protective cover. Litter and the presence of plant roots are very important in the prevention of excessive damage. Consequently, sites with high erosion hazards should be immediately seeded to a herbaceous cover. Interplanting shrubs and trees would also be very beneficial. But trees and shrubs establish slowly from broadcast seedings, and do not provide a satisfactory cover for a number of years.

OBJECTIVE 4

PLANT COMPOSITION CHANGES

In the fall of 1972 a series of plots were established on a benched cut and a fill slope to evaluate the effects of grass competition upon the survival of shrub and tree seedlings. Grasses and other herb seedlings are competitive with slower developing trees and shrubs, and have suppressed their growth and survival, particularly on fill slopes. Since it is difficult to plant grasses and other herbs separately from slower developing woody plants, improvements to the present system of mixed seedings would be very beneficial. Consequently studies were conducted to evaluate seeding different rates of grasses, dates of planting, and fertilizer treatments on tree and shrub survival. Grasses were seeded in separate plots at rates of 10, 5, and 2½ pounds per acre. All plots were also seeded to 20 pounds of tree and shrub seeds. Two additional treatments were used; one in which only shrubs were planted, and a second plot where grasses were seeded a year after the woody plants were planted. All plots were divided in half and one-half was fertilized at the time of planting. The first year emergence and survival of tree and shrub seedlings is recorded in Table 4 for studies conducted on the Mullan Bench site.

Although first year data can be misleading, plantings which consisted of less than 2½ pounds of grass seed per acre recorded between 3 and 9 times more tree and shrubs seedlings per acre than the plots seeded to 5 and 10 pounds of grass seed. The number of surviving woody plants at the end of the first year period was progressively greater as the amount of grass seed added to the mixture was reduced. The number of tree seedlings counted in May and June was similar for all treatments. After this date, no additional shrub and tree seedlings were recorded for plots seeded to 5 and 10 pounds of grass seed. The number of shrub and tree seedlings continued to improve for all other treatments, with the highest counts being recorded in August.

The large number of shrubs recorded in plots with little or no grass seedlings results from plants of Holodiscus and Ceanothus. These are small seeded species and plants are often grouped in clusters as the seeds often are not evenly distributed.

It is somewhat surprising that the grasses would suppress the mid-summer emergence and survival of trees and shrub seedlings. Although the interactionof grass competition will require additional data, other

Table 4. NUMBER OF TREE & SHRUB SEEDLING PER ACRE RECORDED FOR THE MULLAN BENCH

Plots	Tree Seedlings				Shrub Seedlings				Total Seedlings
	05/73	06/73	07/73	08/73	05/73	06/73	07/73	08/73	
10 lbs. Grass									
Unfertilized	772	966	3,354	3,714	386	1,353	1,434	2,396	6,110
Fertilized	193	1,353	3,834	3,354	386	2,513	6,589	3,474	6,828
5 lbs. Grass									
Unfertilized	0	2,705	3,714	4,913	193	966	2,878	2,635	7,548
Fertilized	193	1,353	3,714	3,234	0	579	5,990	4,312	7,546
2 1/2 lbs. Grass									
Unfertilized	386	5,413	9,707	12,223	1,160	3,672	7,786	12,822	25,045
Fertilized	193	5,606	6,351	7,309	386	11,214	17,956	14,380	21,689
No Grass									
Unfertilized	772	2,706	12,702	12,943	2,126	1,933	14,739	19,532	32,475
Fertilized	0	2,899	4,553	5,032	0	2,900	11,384	18,335	23,367
Delay Grass Seeding									
Unfertilized	193	3,286	9,586	10,426	580	1,353	10,186	8,987	19,413
Fertilized	772	4,252	9,347	9,826	579	3,093	33,675	42,905	52,731

plantings have demonstrated similar responses. However, from earlier studies on all slopes grass competition became critical to tree and shrub survival when the herbaceous ground cover approached 40% density. Less than 20% ground cover was recorded for seeded grasses for any treatment. An obvious improvement in the vigor and growth of the grasses can be expected as plants mature.

However, from first year data improvements in the number of surviving tree and shrub seedlings can be attained if the grass mixture is reduced between 2½ and 5 pounds per acre. The reduction in grasses has not resulted in an unsatisfactory herbaceous cover. The number and distribution of grasses is sufficient to develop adequately. A dense stand will be delayed for a few years as the plants mature and spread. In situations where surface erosion is not a major problem the delay does not appear to be critical.

Regulating the application rates and types of fertilizers used can also be an effective means of manipulating the vigor and growth of seeded herbs. Delaying the fertilization of infertile sites may benefit the survival of trees and shrubs, particularly if the woody plants are allowed to establish before the fertilization program begins.